Announcements

- Homework for tomorrow…

  Ch. 31: CQ 3, Probs. 1, 6, & 8

  CQ10: a) doubles b) unchanged c) unchanged d) doubles

  30.18: τ_{Al} = 2.1 x 10^{-14} s, τ_{Fe} = 4.3 x 10^{-15} s

  30.20: a) 10 V/m b) 6.7 x 10^{6} A/m^2 c) 6.2 x 10^{-4} m

  30.22: Nichrome

- Office hours…

  MW 10-11 am

  TR 9-10 am

  F 12-1 pm

- Tutorial Learning Center (TLC) hours:

  MTWR 8-6 pm

  F 8-11 am, 2-5 pm

  Su 1-5 pm

Chapter 31

Fundamentals of Circuits

(*Kirchoff's Laws and the Basic Circuit & Energy and Power*)

Review…

- *Kirchoff's junction rule..*

$$\sum I_{in} = \sum I_{out}$$

- *Kirchoff's loop rule…*

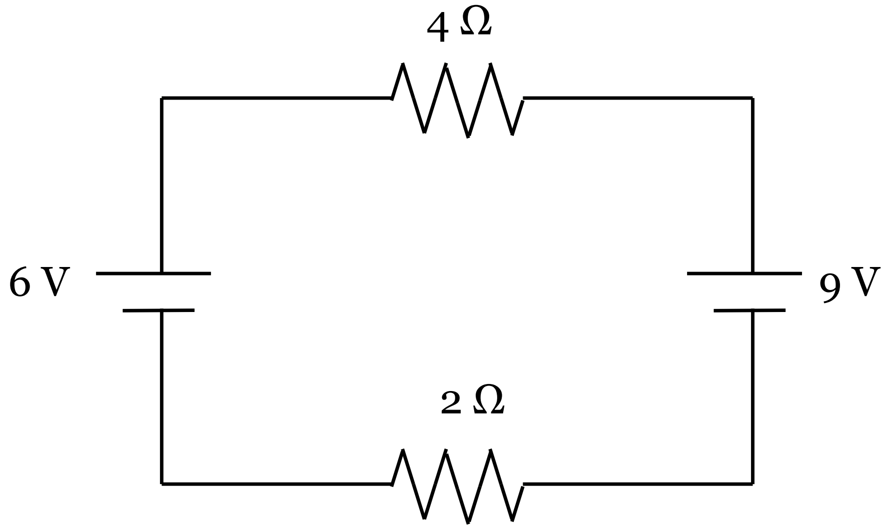
$$\sum (\Delta V)_i = 0$$

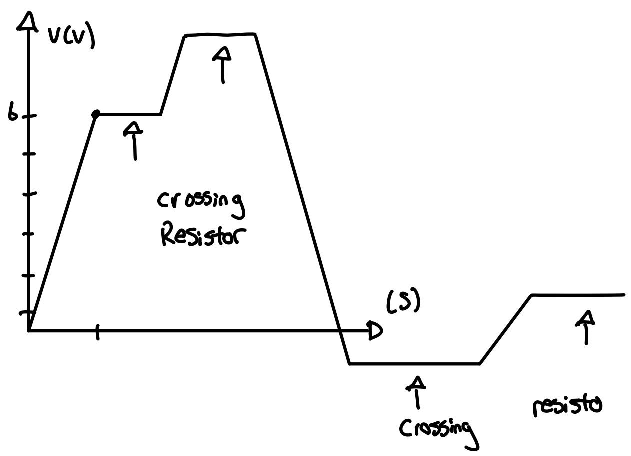
i.e. 31.1: Two resistors and two batteries

Analyze the circuit shown in the figure.

a. Find the current in and the potential difference across each resistor.

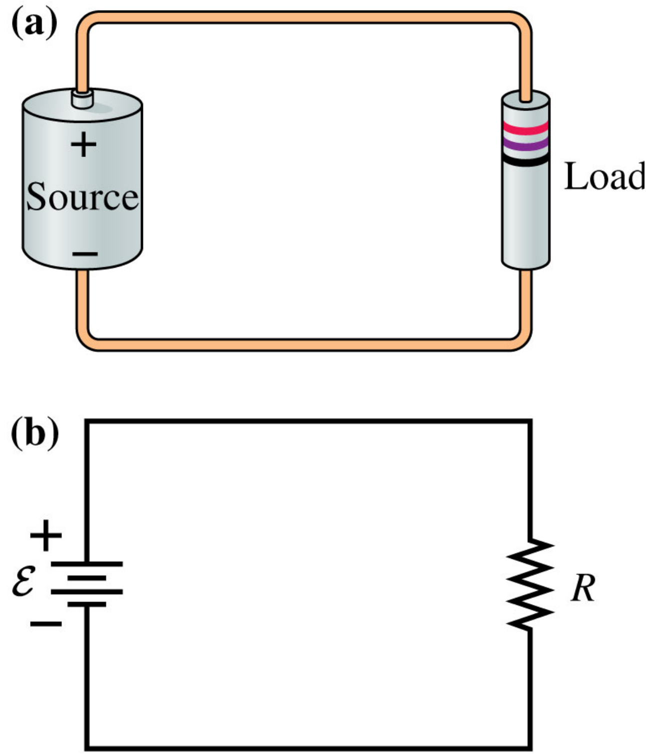
b. Draw a graph showing how the potential changes around the circuit, starting from V = 0V at the negative terminal of the 6 V battery.





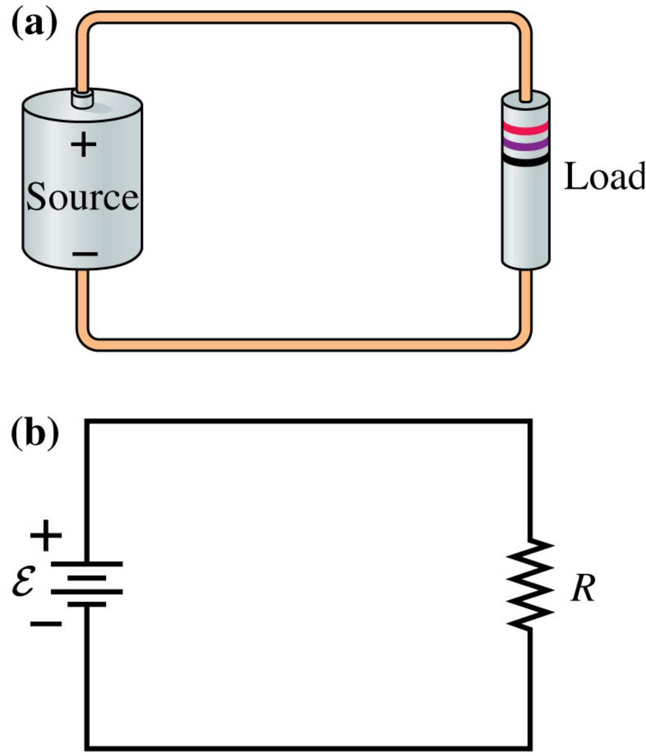
The Basic Circuit

Consider the basic circuit shown…



The Basic Circuit

Consider the basic circuit shown…



Notice:

1. NO junctions, SAME I everywhere.
2. Assuming ideal wires ($R_{wire} \sim 0$).

Quiz Question 1

The potential difference across the 10 Ω resistor is…

$$I = \frac{\Delta V}{R}$$

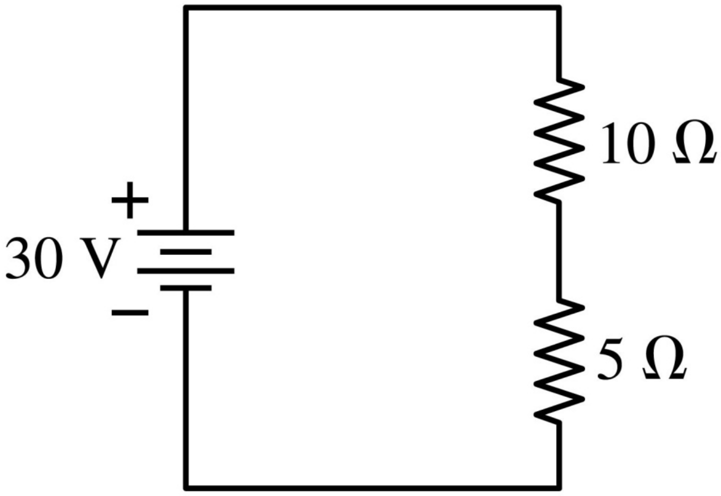
$$\Delta V = IR$$

$$30V = I(15\Omega)$$

$$I = 2.0A$$

$$\Delta V = 2.0A(10\Omega)$$

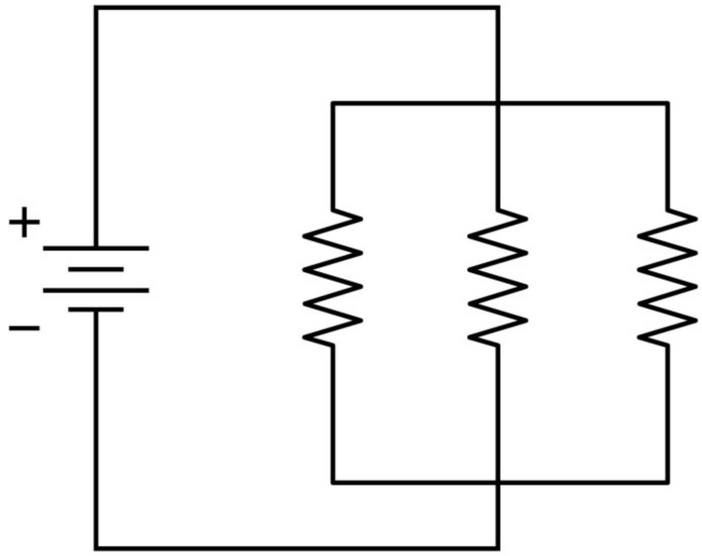
$$\Delta V = 20V$$



1. 30 V.
2. 20 V.
3. 15 V.
4. 10 V.
5. 5 V.

Quiz Question 2

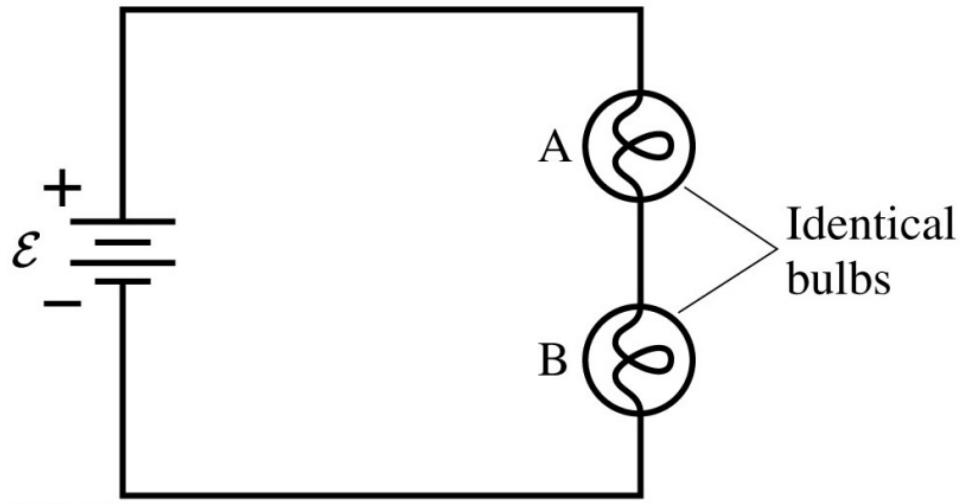
What things about the resistors in this circuit are the same for all three?



1. Current, I.
2. Potential difference, ΔV.
3. Resistance, R.
4. 1. and 2.
5. 2. and 3.

Quiz Question 3

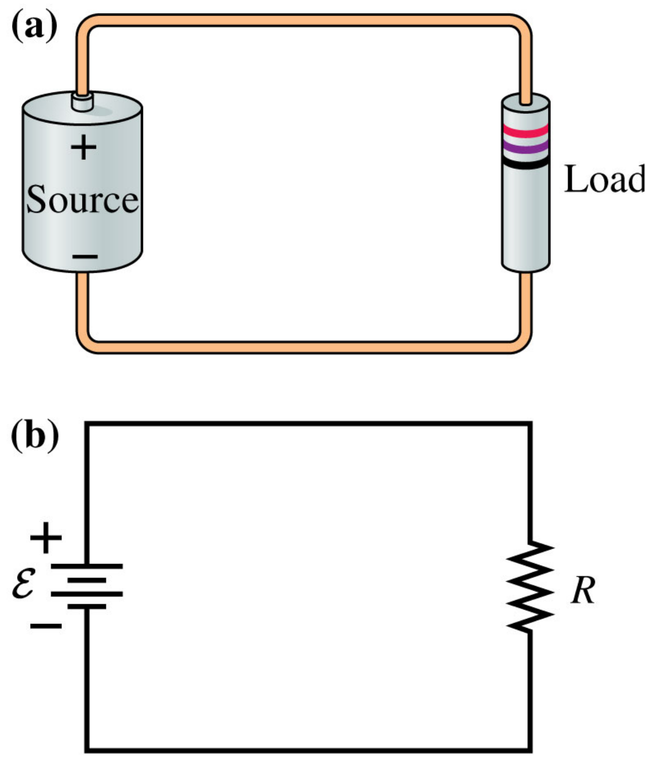
Which light bulb is brighter?



1. Light bulb A.
2. Light bulb B.
3. Both are the same brightness.

31.3:
Energy and Power

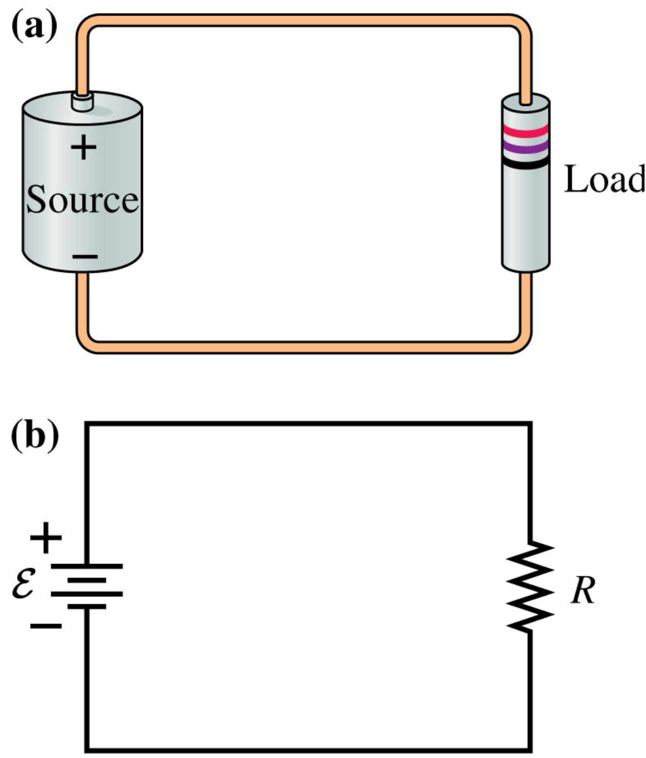
Current is NOT used up by the light bulb, ENERGY is!



31.3: Energy and Power

Current is NOT used up by the light bulb, ENERGY is!

Q: What is the rate at which the battery supplies energy to the charges?



A charge gains potential energy

$$\Delta U = q\Delta V = U - \cancel{U_0}$$

an ideal battery

$$\Delta V_{Bat} = \mathcal{E}_{mf}$$

$$U = q\mathcal{E}$$

$$P_{Bat} = \frac{du}{dt} = \frac{d}{dt}(q\mathcal{E}) = \mathcal{E}\frac{dq}{dt}$$

$$= I\mathcal{E}$$

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Energy and Power

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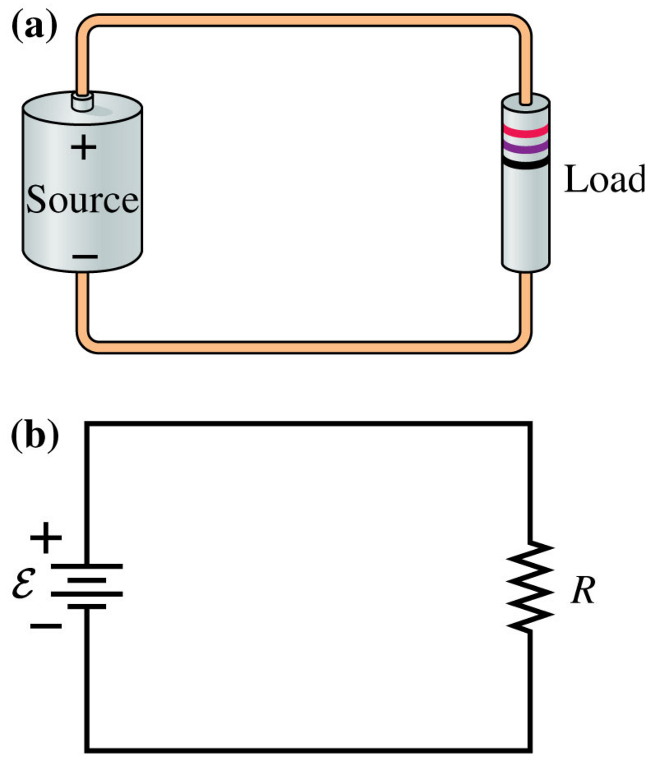
Q: What is the rate at which the battery supplies energy to the charges?



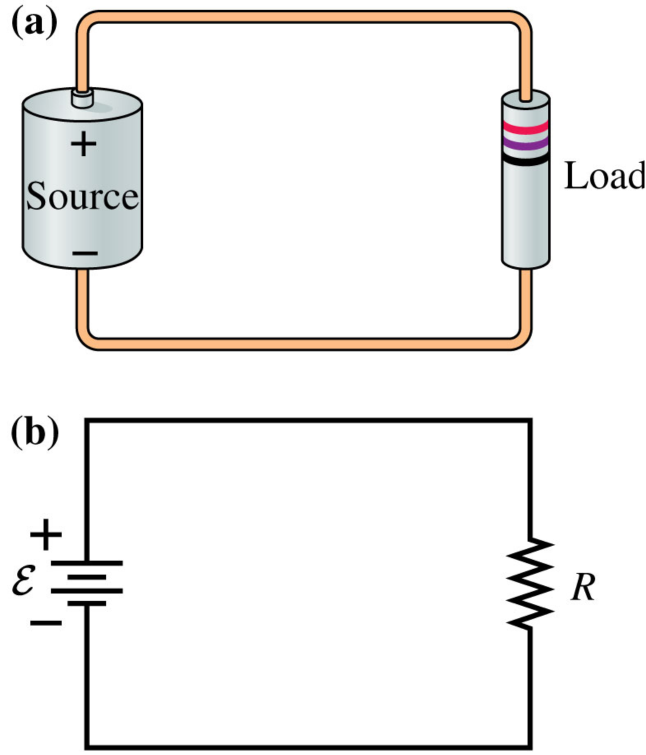
A: $\boxed{P_{bat} = I\mathcal{E}}$

SI Units?

31.3: Energy and Power

Current is NOT used up by the light bulb, ENERGY is!

Q: What is the rate at which the battery supplies energy to the charges?



A: $\boxed{P_{bat} = I\mathcal{E}}$

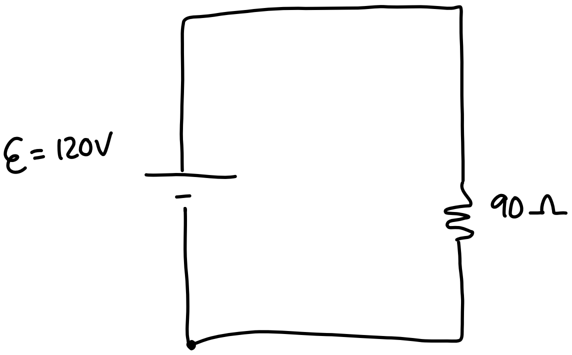
SI Units?

$[P]$ = J/s or W

i.e. 31.2: Delivering Power

A 90 Ω load is connected to a 120V battery.

How much power is delivered by the battery?



$$120V - I(90\,\Omega) = 0$$

$$I(90\,\Omega) = 120V$$

$$I = 4/3\,A$$

$$P_{Bat} = I\varepsilon$$

$$= (4/3\,A)(120V)$$

$$P_B = 160\,W$$

$P_B = 160\,W$

31.3:
Energy and Power

P_{bat} is the *energy transferred per second* from the battery's store of chemicals to the moving charges that make up the current.

31.3: Energy and Power

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Q: Where does that energy go?

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Energy and Power

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Q: Where does that energy go?

A: $$E_{chem} \rightarrow U \rightarrow K \rightarrow E_{th}$$

- The battery's *chemical energy* is transferred to the *thermal energy* of the resistors.
- The *rate* at which the battery supplies energy is *exactly equal to* the *rate* at which the resistor dissipates energy!

i.e. 31.3: The power of light

How much current is "drawn" by a 100 W light bulb connected to a 120 V outlet?

What's the resistance of the light bulb?

$P_{Bat} = I\mathcal{E}$

$\Delta V = IR$

$R = \frac{\Delta V}{I}$

$P = I\mathcal{E}$

$I = \frac{P}{\mathcal{E}}$

$\mathcal{E} = 120V$

$I = ?$

$P_{bat} = 100W$

$R = 144\,\Omega$

$I = 0.83A$

$I = 0.83A$
$R = 144\,\Omega$

31.3:
Energy and Power

Power dissipated by a resistor..

$P_R = I\Delta V_R$

$I = \frac{\Delta V}{R}$

$\Delta V = IR$

$P_R = \frac{\Delta V_R^2}{R}$

$P_R = I^2 R$

31.3:
Energy and Power

Power dissipated by a resistor..

$$\boxed{P_R = I\Delta V_R = I^2 R = \frac{(\Delta V_R)^2}{R}}$$

Notice:

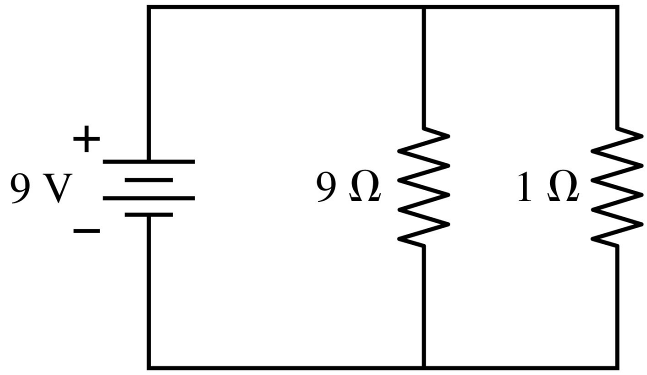
For resistors in *series*, the resistor with the *largest* resistance dissipates the *most* power.

For resistors in *parallel*, the resistor with the *smallest* resistance dissipates the *most* power.

Quiz Question 4

Which resistor dissipates more power?

$I = \frac{\Delta V}{R}$ $\Delta V = IR$



1. The 9 Ω resistor.
2. The 1 Ω resistor.
3. They dissipate the same power.